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THE DESIGN AND FABRICATION OF A PROTOTYPE TRASH COMPACTING UNIT

Final Report

April 1, 1973

Prepared under Contract No. NAS1-11031

by

INDUSTRIAL ECOLOGY, INC.
Los Angeles, California

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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THE DESIGN AND FABRICATION OF A PROTOTYPE TRASH COMPACTING UNIT

INTRODUCTION AND SUMMARY

As the duration and complexity of manned space flights increase, so does the general problem of waste management. This area is divided into several subcategories, including body waste, garbage, and dry nonbiodegradable trash. It is toward the latter problem that the program described in this report is directed.

In an attempt to provide an esthetically acceptable method of trash disposal, coupled with maximum flexibility in storage, the Industrial Ecology Corporation--in conjunction with NASA--has developed a prototype trash compactor that is compatible with the anticipated requirements of future long-term space missions.

Preliminary problem definition studies were conducted to identify typical types and quantities of waste materials to be expected from a typical mission. Bench-scale compaction tests were then conducted on typical waste materials to determine force/compaction curves. These data were used to design a boilerplate compactor that was fabricated to prove the feasibility of the basic design concept. A final design was then prepared from which the deliverable unit was fabricated.

Design concepts are presented for suggested further development of the compactor, including a version that is capable of handling wet biodegradable wastes.

TECHNICAL PROGRAM

As the beginning of a logical stepwise approach to the total management of solid wastes in manned space missions, the development of a device to significantly reduce the volume required for the storage of dry trash has been accomplished. Preliminary investigation concerning the expected types and quantities of dry trash were used to dictate design and fabrication of a prototype trash compacting unit for use in future manned space missions.

Preliminary Problem Definition Studies

Probably the most realistic simulation of a long-term closed manned space mission was the NASA-sponsored 90-Day Manned Test. Results of this test showed an overall average of 0.6 pounds per man-day of dry trash. The reported total volume was approximately 15 cubic feet. This averaged approximately 73 cubic inches per man-day for each of the four-man crew. This volume data is somewhat hard to interpret, since some of the trash was bundled for storage. In addition, some of this volume consisted of food trays, which, when stacked, approached a density of solid plastic, while loose aluminum foil was balled up with an unknown pressure.

The above data point up the difficulty in reporting the loose or uncompacted volume of materials. A good example is an 8-1/2" x 11" sheet of paper. A flat sheet is quite compact, but quite unwieldy to dispose of, while when crumpled into a ball it is easy to handle, but of rather large volume. A ball that is then compressed results in the ultimate in both handling convenience and low volume.

Force/Compaction Studies

Experimental compaction tests were conducted on representative samples of trash selected from the typical items encountered in the 90-day test summarized in table I.

Test procedure. — The force/compaction tests were accomplished using the pneumatically operated test apparatus shown in figure 1.

The force cylinder assembly consisted of a vertically mounted pneumatic cylinder with a 3-inch-diameter piston and a 3/4-inch-diameter shaft with a 13-inch stroke. A compacting piston 3-1/8 inches in diameter and 4 inches long was connected to the shaft via a swivel joint. The test cylinder was a plexiglass tube 3-3/16 inches ID and 12 inches long, with a 3/8-inch wall.

The compaction load and rate were controlled by a hand valve that regulated the flow of compressed air to the force cylinder. The forces were measured on a 0-30-psi gage with 0.05-psi divisions.

The tests were conducted by filling the plexiglass tube with as much mixed trash as could easily be forced in by hand with approximately the same force as one normally uses in filling an ordinary wastebasket. This volume was called "the loose volume." The piston was then actuated and the depth of the material recorded as a function of force. When the force reached 200 pounds, the final depth was recorded after holding for 30 seconds. The piston was then removed, and the cylinder was refilled again with as much as could easily be packed in by hand. Another force/compaction set of data was then recorded.

TABLE I. — DRY TRASH FROM NASA 90-DAY MANNED TEST

Total Dry Waste

Bundled--12.02 ft^3--196.5 lb

Other Waste--3.18 ft^3--17.6 lb

Man-Day Averages (4 Men--90 Days)

Bundled (Food Packages)--0.033 ft^3/man-day--0.55 lb/man-day
(Aluminum Foil)--(57.02 $in.^3$)

Other Dry Waste (Misc.)--0.009 ft^3/man-day--0.049 lb/man-day
(15.6 $in.^3$)

Assume one standard deviation = 50% above values

Typical Mean Man-Day Package (Bundled and Other) (72.6 $in.^3$) - (0.6 lb)

8 plastic food packages

50 $in.^2$ aluminum foil

3 foam cups

2 small cardboard boxes

4 small food packages (salt, sugar, etc.)

24 in. balled masking tape (or adhesive)

100 $in.^2$ rag (or Kemwipes)

6 Q-Tips

4 tongue depressors

To weight--8-1/2" x 11" paper to bring to mean weight and volume

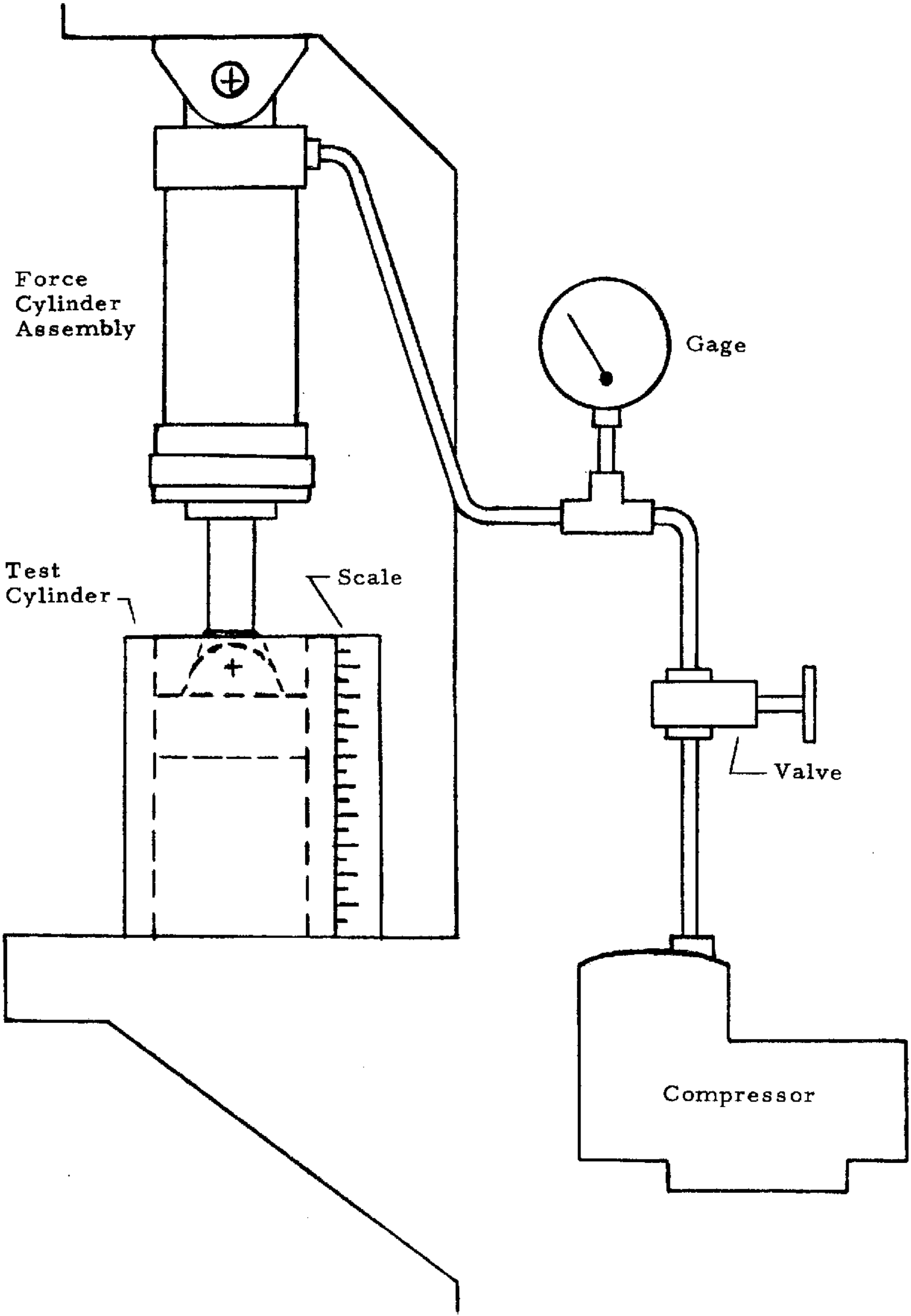


FIGURE 1. — FORCE/COMPACTION TEST APPARATUS

This process was continued until the depth of compressed material reached about 7 inches. At this point, it was felt that the remaining volume of the tube that could be filled with loose material was about the minimum practical filling volume. The compacted material was then observed over a period of 15 minutes. The recovery, or self-expansion, was recorded, and the trash mixture was forced out of the tube by supporting the tube above the base.

Approximately 30 pounds of force was required to force the compacted material out of the tube.

Test results. — The order and quantities of materials that comprised two of the representative tests are listed in tables II and III. The test results are shown in figures 2, 3, and 4.

The data shown in the figures were reduced from the tabulated data by dividing the loose depth by the additional final depth caused by each addition of material as listed in tables II and III. The degree of scatter for the various material mixtures as shown in figure 4 is surprisingly small. Items such as empty cardboard boxes and plastic cups and bottles resulted in a very large percent of compaction due to their large original volume. Other materials that could be loaded in rather compact form--such as rags and tissues--showed a rather small percent of compaction, although the result is very high-density packing. Incompressible objects such as broken pencils and tongue depressors showed essentially no effect. If these happened to lie nearly horizontal to the tube axis, they merely ended up in a horizontal position. If vertical, they broke until the pieces became horizontal, or, if they were short enough, they remained vertical with the more compressible material closely packed around them.

The shaded area representing the composite data points in figure 4 clearly shows that compaction forces that are much in excess of 150 pounds do not result in any appreciable compaction. Therefore, the design of a machine capable of more than 30 psi is not necessary. Commercial units such as that sold by Sears produce a much lower pressure (2,000 pounds over an 8-by-14-inch piston, or 18 psi).

The recovery data shown in tables II and III show very little springback as long as the material remains in the tube. Recovery volumes for each load were not recorded, since the material is recompressed by subsequent loads. The final recovery volume is significant because it represents the final package volume; however, as soon as it is pushed out of the tube, the material quickly expands to almost 150 percent of its compacted volume before recovery. This suggests that the bagging operation of the prototype compactor will be quite simple as long as the compacted material is contained radially.

TABLE II. — TEST RESULTS, PACKAGE 1A

LOAD #1

3	food packages	
1	aluminum foil	
1	small paper bag	1.4 oz
2	foam cups	V_1 = 130 in.^{3}
2	8-1/2" x 11" paper	V_2 = 26 in.^{3}
1	broken pencil	

LOAD #2

3'	masking tape	
1	cardboard box	2.1 oz
1	food bag	V_1 = 104 in.^{3}
2	8-1/2" x 11" paper	V_2 = 21 in.^{3}

LOAD #3

1	foam cup	
1	cardboard box	
1	broken pencil	3.00 oz
18"	35-mm film	V_1 = 83 in.^{3}
1	rag, 2 ft^2	V_2 = 6 in.^{3}
1	plastic bottle	

LOAD #4

1	food bag	1.4 oz
1	paper container	V_1 = 77 in.^{3}
2	8-1/2" x 11" paper	V_2 = 8 in.^{3}
1	plastic bottle cap	

TOTAL 7.9 oz (82% mean man-day)
V_1 = 394 in.^{3}
V_2 = 61 in.^{3}
V_3 = Recovered volume after 15 minutes = 69 in.^{3}

V_1 = Loose fill volume
V_2 = Compacted volume

TABLE III. — TEST RESULTS, PACKAGE 1B

LOAD #1	
1 food package 1 plastic pill bottle 1 tongue depressor 2 8-1/2" x 11" paper 1 aluminum foil 1 plastic cup 1 cardboard box	2.5 oz V_1 = 130 in.^{3} V_2 = 27 in.^{3}
LOAD #2	
3 8-1/2" x 11" paper 1 plastic dish cover 1 papier mache container 1 plastic container	3.10 oz V_1 = 103 in.^{3} V_2 = 6 in.^{3}
LOAD #3	
1 rag 1 steel wool 1 Penlite battery 1 plastic bottle cap 2' masking tape 1 nail 1 foam cup 1 broken pencil 1 plastic bottle cover 10 paper clips	3.4 oz V_1 = 97 in.^{3} V_2 = 14 in.^{3}
LOAD #4	
1 Popsicle stick 1 cardboard box 1 latex lump	2.2 oz V_1 = 83 in.^{3} V_2 = 18 in.^{3}
TOTAL	11.20 oz (117% mean man-day) V_1 = 413 in.^{3} V_2 = 65 in.^{3} V_3 = Recovered volume after 24 hours - 92 in.^{3}

V_1 = Loose fill volume
V_2 = Compacted volume

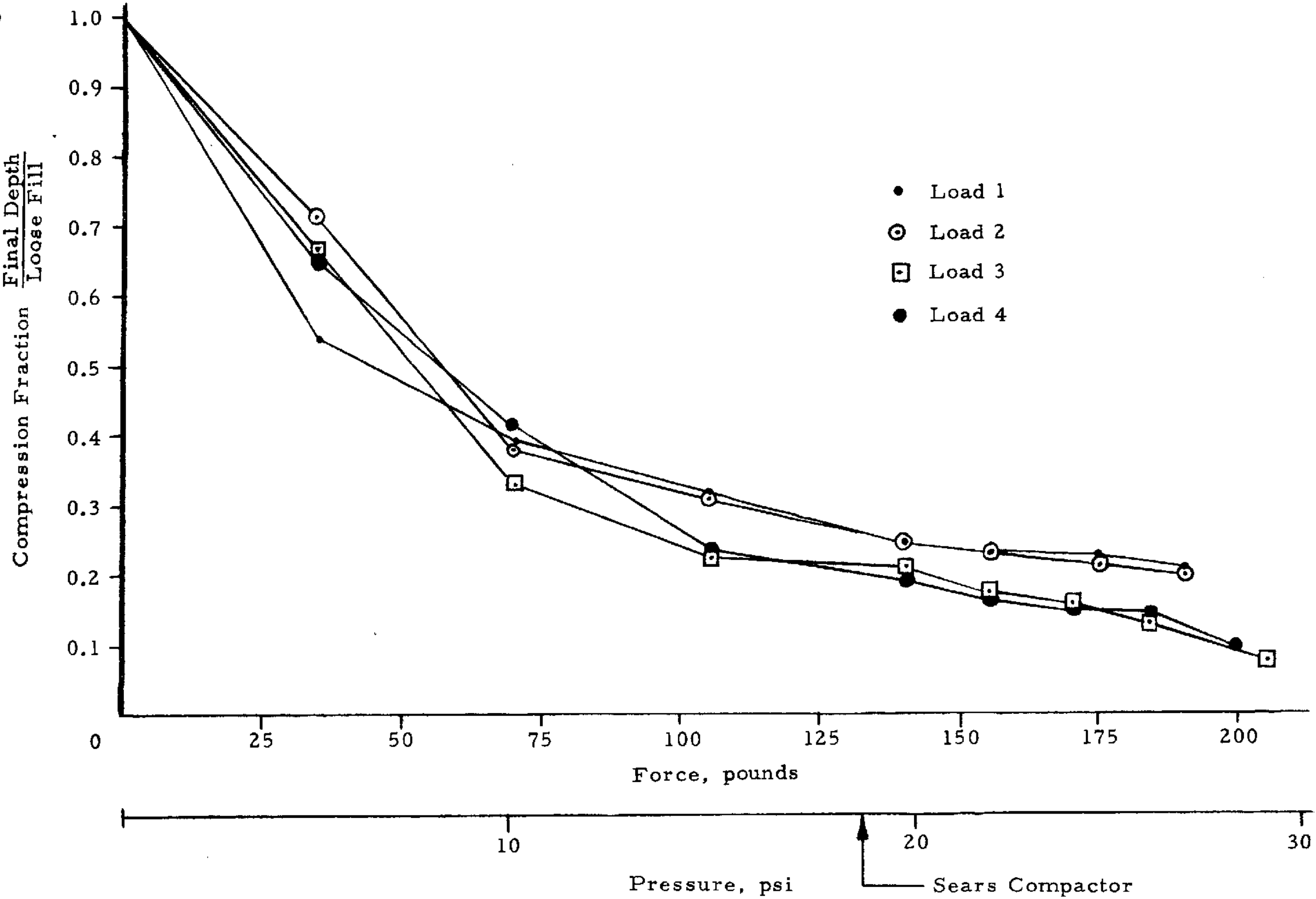


FIGURE 2. — FORCE/COMPACTION DATA, PACKAGE 1A

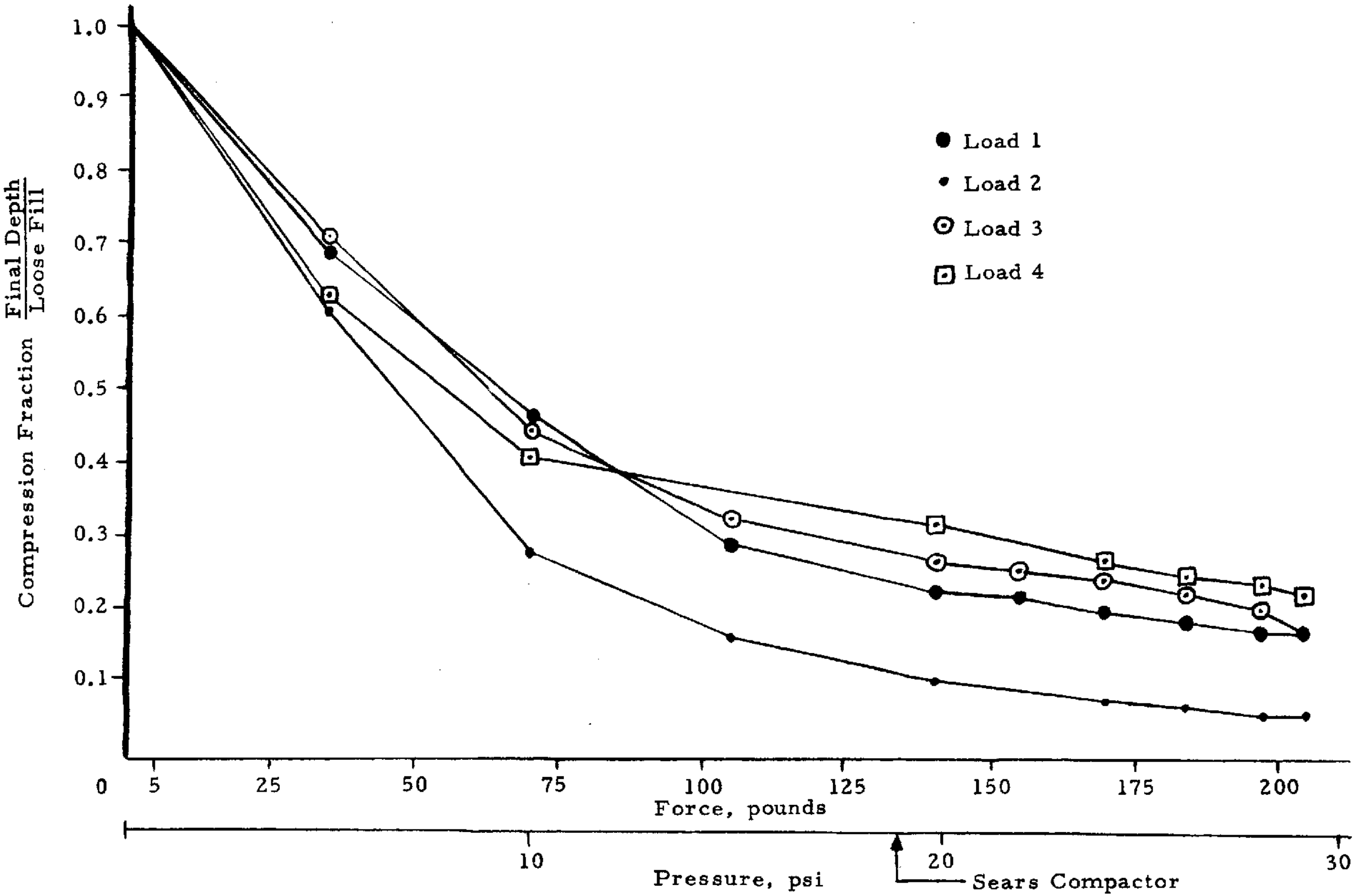


FIGURE 3. — FORCE/COMPACTION DATA, PACKAGE 1B

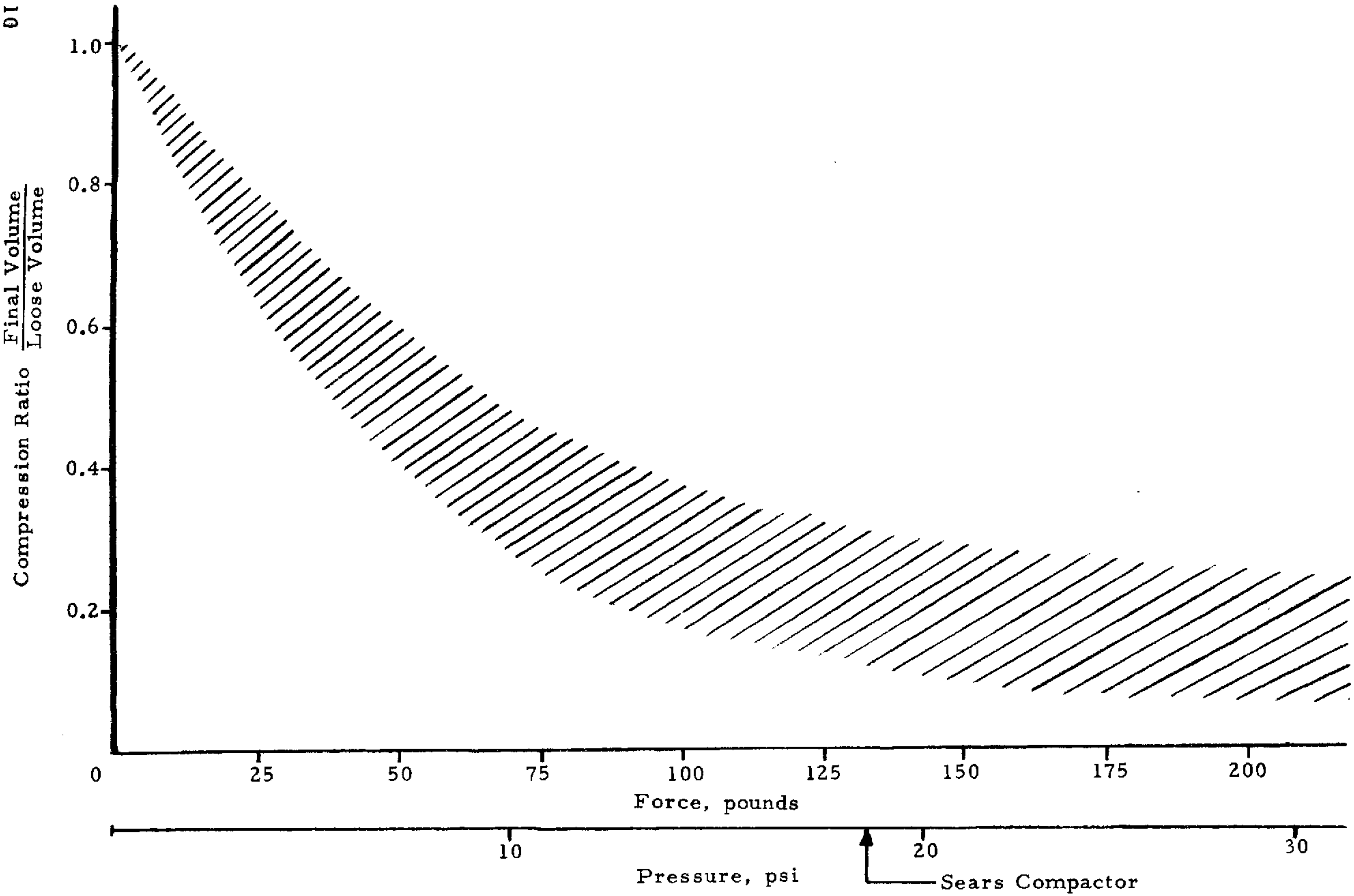


FIGURE 4. — COMPOSITE COMPACTION DATA FOR TRASH MIXURES

Preliminary Design

The preliminary design concept based on the force/compaction bench tests is shown in figure 5. The compaction tube is 3.5 inches in diameter and 18 inches long. The right 10 inches is the compaction area, with the left portion as the loading area. The right end of the tube is not attached to the cover, thus allowing the bag to be slipped over the end. The plate on which the motor and gearbox are mounted slides on the tie rods. As the piston is driven to the right, the springs compress to a preset load, at which point a limit switch stops the motor, reverses it, and returns the piston to its original position.

The motor/gearbox consists of a modified Lear Model 420AW-2 aircraft linear actuator. This item is very small and compact, and, since it was built to Milspec, it provides a very efficient and reliable power unit. Therefore, a deviation from the contract Statement of Work was requested to allow the use of the 24-volt enclosed dc motor instead of the 115-volt ac explosion-proof motor previously required. The motor is rated at 24 volts, 12 amps. The linear actuator in its original form was rated at 700 pounds' compression and is thus more than adequate for the trash compactor. The only modification required is the replacement of the shaft, since the original travel of the actuator is only 5-1/4 inches. The shaft is a standard 5/8-inch Acme thread. Therefore, the original drive mechanism was used.

The loading-compartment door consists of a concentric stainless-steel tube with a hole that matches the loading port. The door is closed by rotating the outer tube 60 degrees so that the ports are opposed.

Bag removal is accomplished by unlatching and opening the end plate and activating the piston. The compacted material is then forced out of the tube, bringing the bag with it and expanding slightly into the bag. Test experience indicates that the bag prevents appreciable springback until it is sealed. A new bag is slipped over the compaction tube, the end plate is replaced, and the unit is ready for use.

The electrical control circuit is shown in figure 6. The operating sequence is initiated by closing and latching the loading door, thus closing the door safety switch, which controls all power to the unit. The door must be latched in order for power to be supplied to any part of the unit; this prevents operation with the door open. The start button is then pushed, causing the self-latching relay, K_1, to close. It should be noted that the open-limit switch is open before the start button is pushed. This switch will close as soon as the motor moves the piston forward, so that an inadvertent instantaneous closure of the start button will not start the unit; it must be held until operation of the motor proceeds. As the piston moves forward, it compresses the trash until the pressure-actuated switch is closed, signifying that the desired force

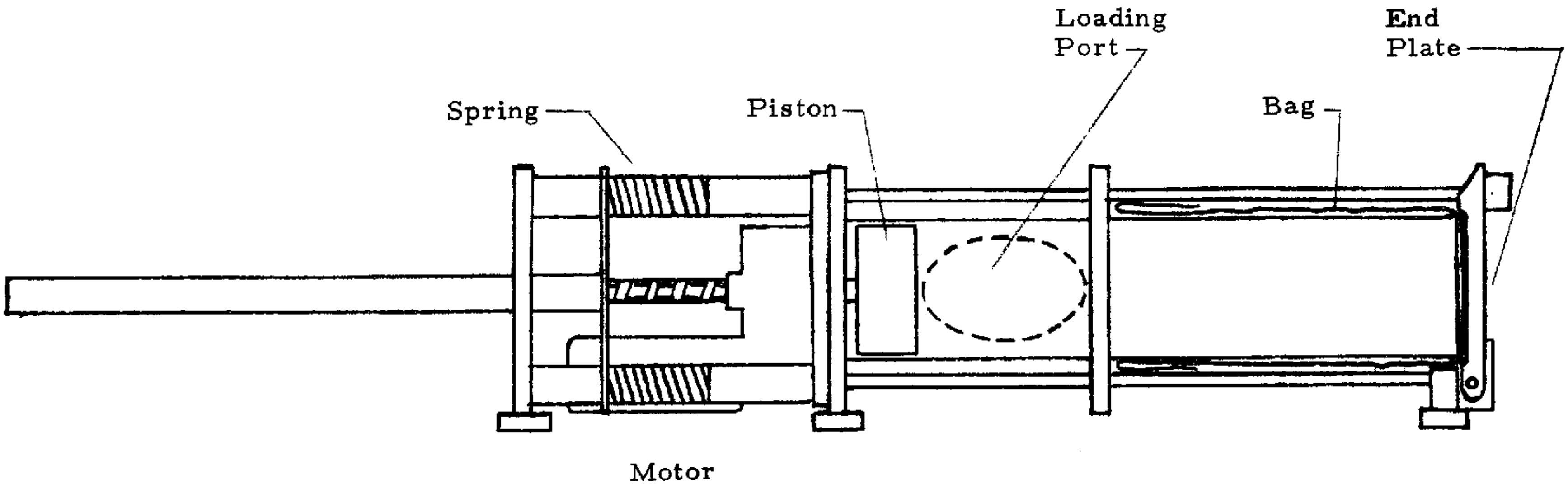
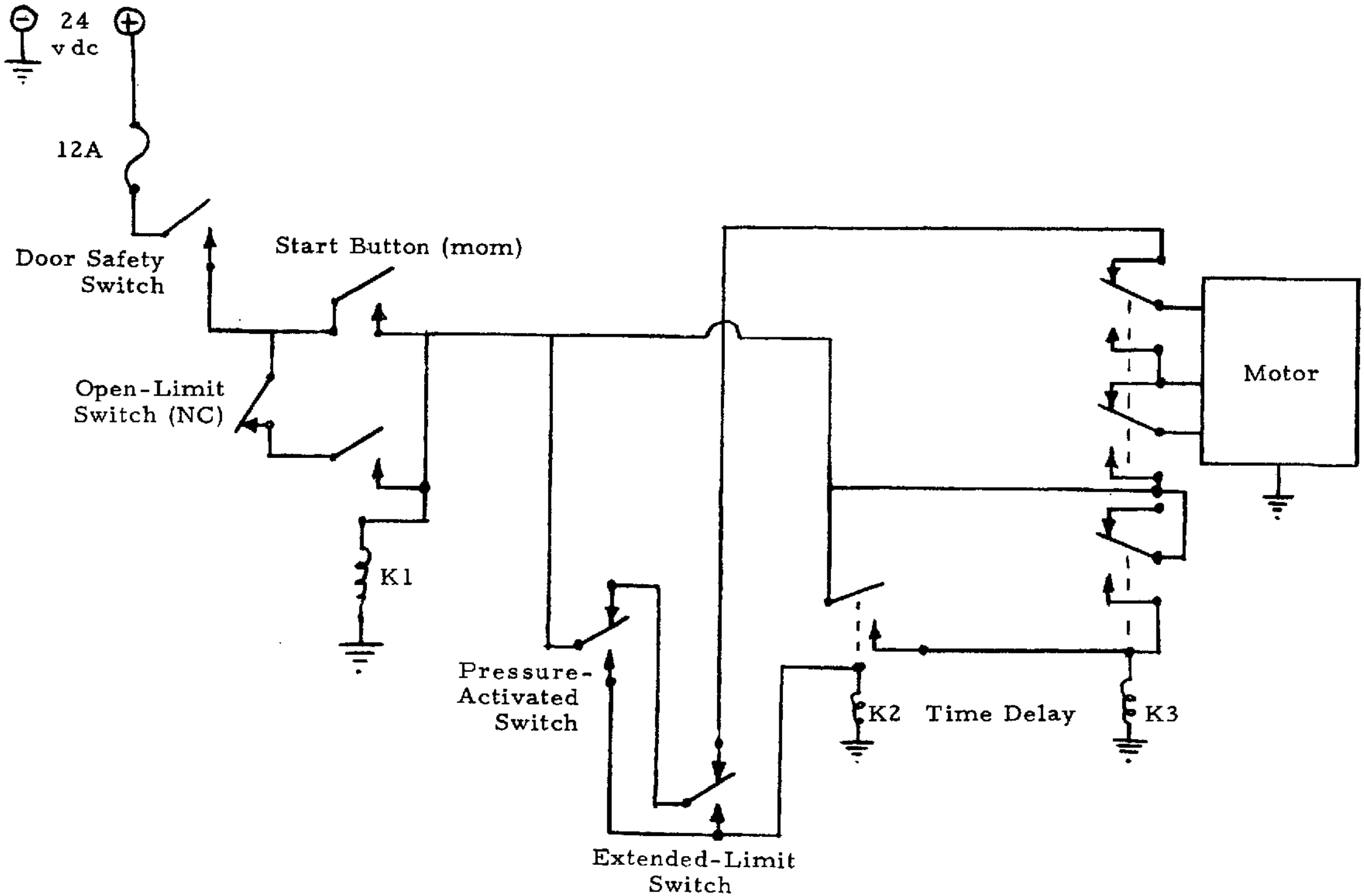


FIGURE 5. — PRELIMINARY DESIGN CONCEPT


24
v dc
12A
Door Safety
Switch
Start Button (mom)
Open-Limit
Switch (NC)
K1
Motor
Pressure-
Activated
Switch
Extended-Limit
Switch
K2
Time Delay
K3

has been reached. Closure of this switch closes K_2, which is a 3-second time-delay relay. This allows the motor to stop before K_3 is closed, which reverses the motor and causes the piston to retract until it reaches its original position. This activates the open-limit switch, which stops all activity. The extended-limit switch stops and reverses the piston either during the bag-removal cycle or in case the unit is started without the end plate being securely fastened.

Tradeoff Studies

The tradeoff studies described below were accomplished after the test program results had defined some of the basic requirements of the unit.

Square versus round packaging was briefly considered; however, the post-compaction results of the tests previously discussed clearly show that square packaging would be impractical. It would require a rigid package to retain the square shape, since the material tends to expand after leaving the compaction tube unless restrained radially. Square configurations would also tend to increase the cost of the machine due to their manufacturing costs, which are greater than those of round shapes. Other considerations such as weight, volume, and power would not be affected by the package shape, and the only potential advantage offered by square packaging would be in cases where storage volume is extremely critical and square packages could be most efficiently stored.

Post-compaction expansion versus time-under-pressure studies were conducted during the force/compaction studies described above. Pressure durations from essentially instantaneous to 15 minutes showed no measurable difference in springback. This may be explained by the general mixture of materials that were observed to take an essentially permanent "set"--such as crushing brittle plastic shapes and folding cardboard boxes--and very elastic materials such as rubber products and rags. The inelastic materials are reduced in volume immediately and will not spring back at all, while the elastic materials do not take a "set" regardless of the time of compression. Thus, holding the material in the compressed state is not necessary to prevent springback.

Material-selection studies were quite simple because the present prototype handles only dry nonbiodegradable materials, and corrosion is not a problem. Aluminum was selected for most low-stress parts such as brackets, housings, etc. High-stress parts, such as the Acme shaft and the load-carrying tie rods, use steel to provide adequate strength without excessive size. The compaction tube actually receives very low stresses, and aluminum would suffice for normal operation. However, accidental damage to the tube could cause piston binding and render the unit inoperational. Therefore, thin-wall stainless steel was selected to provide ruggedness with only a small added weight penalty. Brass was selected for all sliding surfaces to prevent galling between aluminum or stainless-steel surfaces.

Table IV lists the physical and chemical properties of a number of packaging materials. Desirable properties of a packaging material include high tensile, burst, and tear strengths with good fold endurance and and low elongation behavior. As a minimum, the material should be self-extinguishing, but nonignitable material is more desirable. The only five materials that meet the minimum flammability requirement are nylon, polyester, FEP, PVF2, and PVC. From an outgassing and flammability standpoint, the fluorocarbons are the most attractive; however, their physical properties are poor. Fluorocarbon composites incorporating fiberglass fabrics offer ideal solutions to the problem, and the Teflon-impregnated Beta cloth materials currently in wide use in the manned space program offer the ideal solution to the packaging problem. It is therefore concluded that fluorocarbon-impregnated fiberglass fabrics are the most desirable for a flight-type package.

For the prototype compactor, test bags were manufactured from PVC because of its ease of manufacture. These bags worked surprisingly well, in spite of some stretching, and were useful in demonstrating the overall bagging process.

Investigations into the package-sealing methods showed that the twist tie is the most convenient. It is applicable to any bag material, was found to be simple to accomplish, and adequately secured the material after compaction. The use of hog rings fastened with special pliers was found to provide much more strength than really necessary and was sometimes quite difficult to accomplish by one individual. Heat sealing would require a special bag-folding device to accomplish the task, and the process of heat-sealing a bag containing flammable materials in a manned environment presents too many potential problems at the present time.

Boilerplate Test Unit

In order to test the basic design concept, a boilerplate unit was assembled from available scrap stock and components. This unit has proved invaluable in eliminating the "bugs" that always accompany the development of a new design concept. This unit is shown in figure 7.

The bag installation and a closeup of the end-plate assembly is shown in figure 8. The end plate is opened by lifting the T-handle, which is held in place by the stiffness of the 1/4-inch rod. The bag, with a portion folded back, is then slipped over the tube and the cover latched with the T-handle.

TABLE IV. — PHYSICAL PROPERTIES OF CANDIDATE PACKAGING MATERIALS

Characteristics	ASTM	Nylon	Poly-carbonate	Polyester	Polystyrene	Cellophane	Fluorocarbons FEP	Fluorocarbons PVF	Fluorocarbons PVF2	Poly-propylene	Poly-ethylene	PVC
Tensile Strength, 1000 psi	D882	10-13	8	17-18	7-12	7-16	3	7-18	24-36	18-32	4-8	6.5-8.5
Elongation, %	D882	7250	85-100	70-130	3-10	15-50	300-400	115-250	150-200	40-80	200-800	5-200
Burst Strength, psi	D774	--	25-35	45	30-60	45-70	10-15	20-70	--	--	10-15	9-20
Tear Strength, gm/mil	D689	50	10-16	18	2-8	2-15	100-150	12-100	--	5-10	100-300	20-150
Fold Endurance	D643	Exc	250-400	Exc	--	--	4000	--	--	Exc	Good	Good
Chemical Resistance	--	Exc	Good	Exc	Good	Poor	Exc	Exc	Exc	Good	Good	Good
Heat Sealing Range, F	--	400-500	400-430	490	200-300	200-350	600-700	--	360-500	--	300-400	260-400
Max Service Temp, F	--	300	280	250	160-180	300-375	400	225	300	285	250	160-180
Rate of Burning	--	Self-Ext	Slow	Self-Ext	Slow	Fast	Nil	Slow	Nil	Slow	Slow	Self-Ext

[1] 1972 "Materials Selector," Reinhold Publishing Corporation.

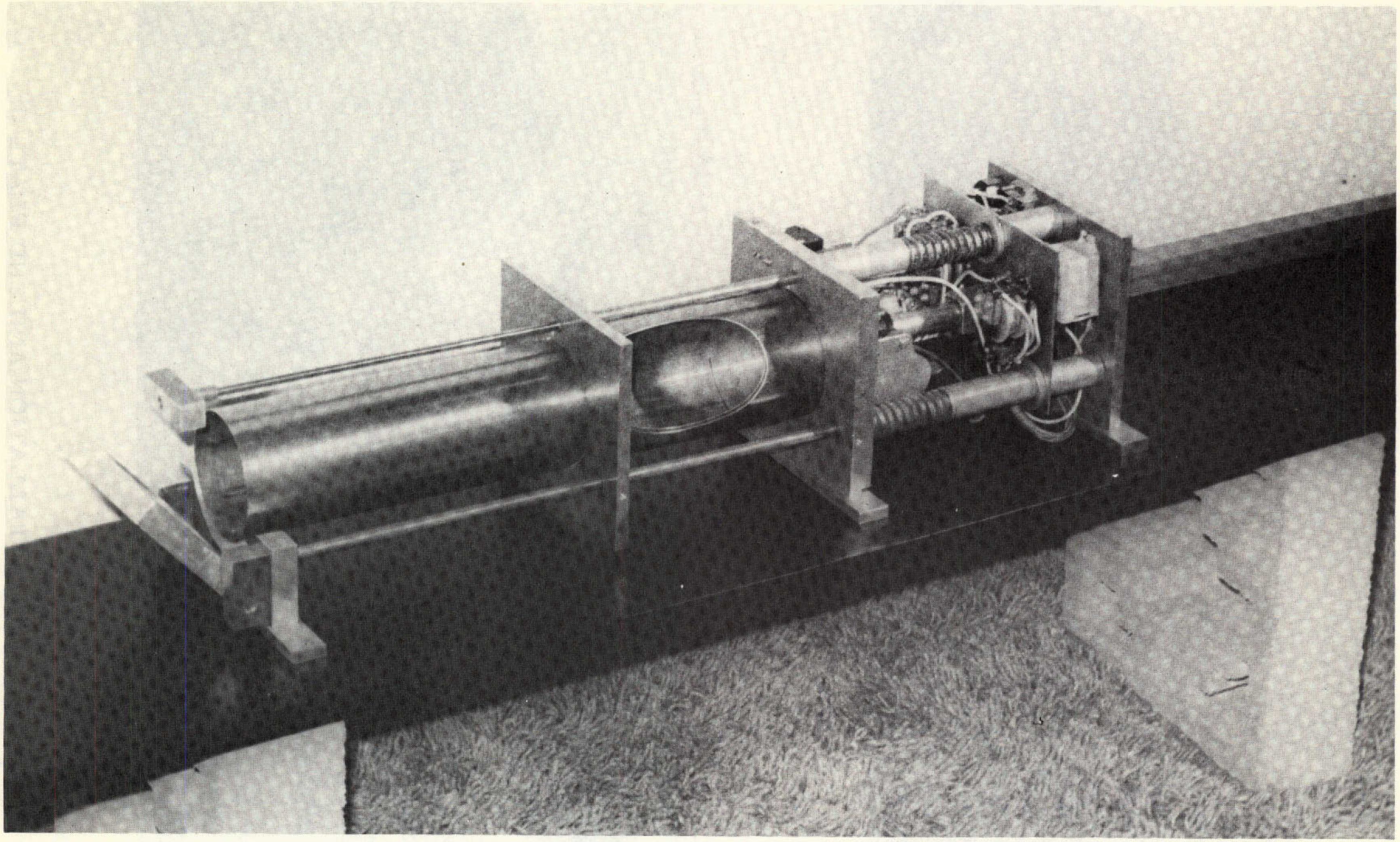


FIGURE 7. — BOILERPLATE TEST UNIT

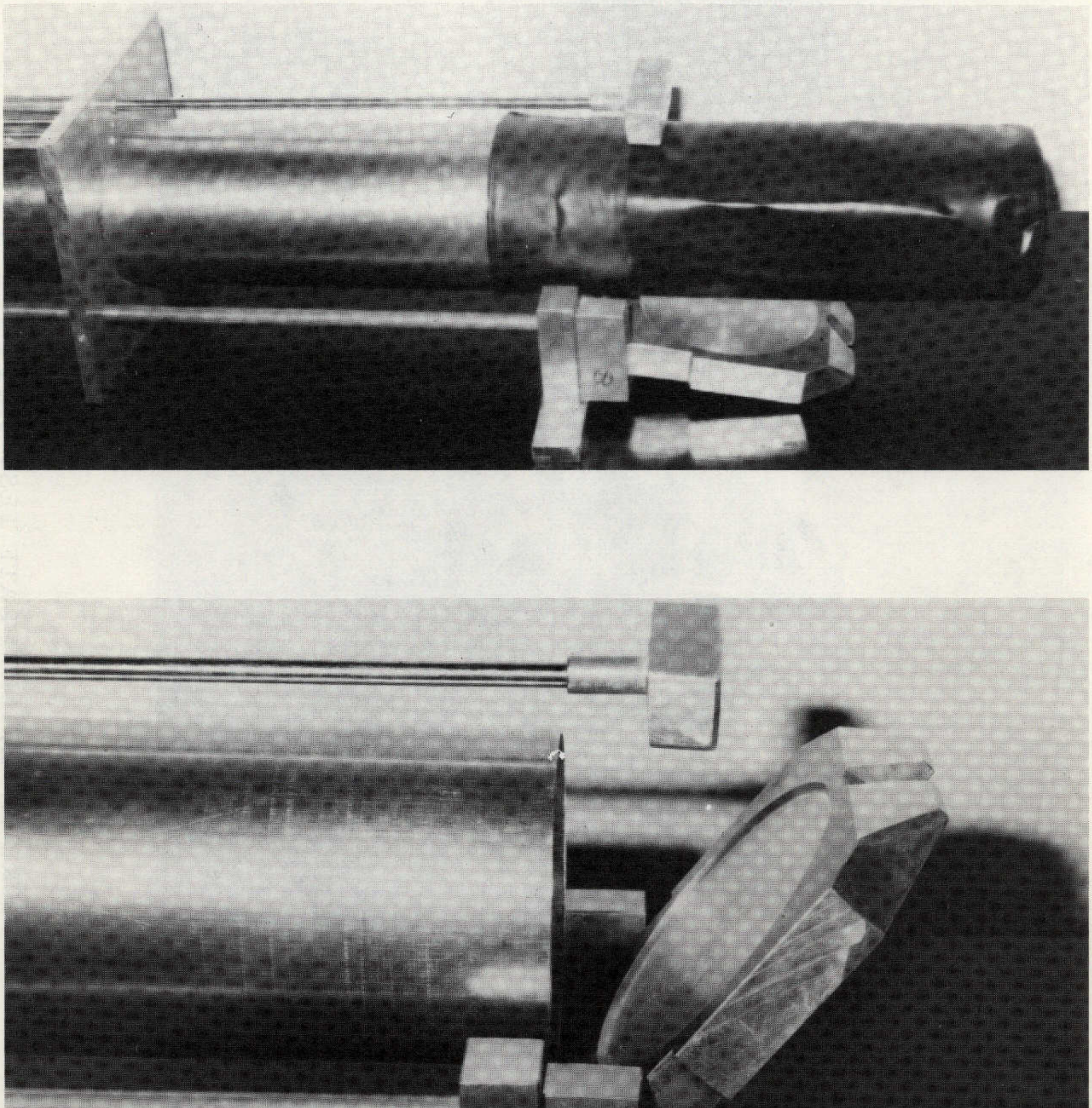


FIGURE 8. — BAG INSTALLATION AND END PLATE

The unit with a bag installed and the loading door closed is shown in figure 9, along with a closeup of the door latch. The pins of the pinch-type latch seat in holes in the two frame plates. The left pin is also used to actuate the door-latch switch via a rod that extends through the frame plate.

Tests with this unit were quite successful and led to the design of the unit that was delivered at the end of the contract period.

Final Design

The delivered unit has been fabricated according to the approved final design drawings previously submitted, with a few minor improvements, the necessity for which became evident during the fabrication and testing of the boilerplate unit. A sketch of the modified outline is shown in figure 10. The use of small hermetically sealed relays makes possible the much smaller triangular outline of the motor housing. The use of lighter materials in the end-plate assembly and a few other parts brings the weight of the delivered unit to less than 25 pounds.

An added convenience in bag installation is provided by adding tabs to the bag interior at the point where it is folded back. Thus, by grasping the tabs, the bag may be more easily fitted over the end of the tube. Tests with the boilerplate unit have shown the use of twist ties to be the the best method of bag closure. After the filled bag is extracted from the compactor, the material in the bag is quite stable, allowing easy closure and sealing with the twist wire.

Fabrication and Test

The deliverable unit was fabricated and assembled according to the final design. The unit is shown in figures 11, 12, and 13. It has an overall length of 45 inches, a maximum width of 6.5 inches, a height of 6.75 inches, and a total weight of 23 pounds. All external aluminum parts are anodized dark blue, the loading door is painted satin black, and the steel tie rods are blue-etched.

Prior to testing, the unit was mounted in a vertical position, and a solid plug was inserted in the compaction tube in a manner that allowed the piston to press against a spring scale. The load switch was adjusted until the unit repeatedly stopped when the force reached between 218 and 230 pounds.

Several loads of trash of compositions representative of the mixtures used during the force/compaction studies were loaded and compacted. No quantitative data were taken because the loading process

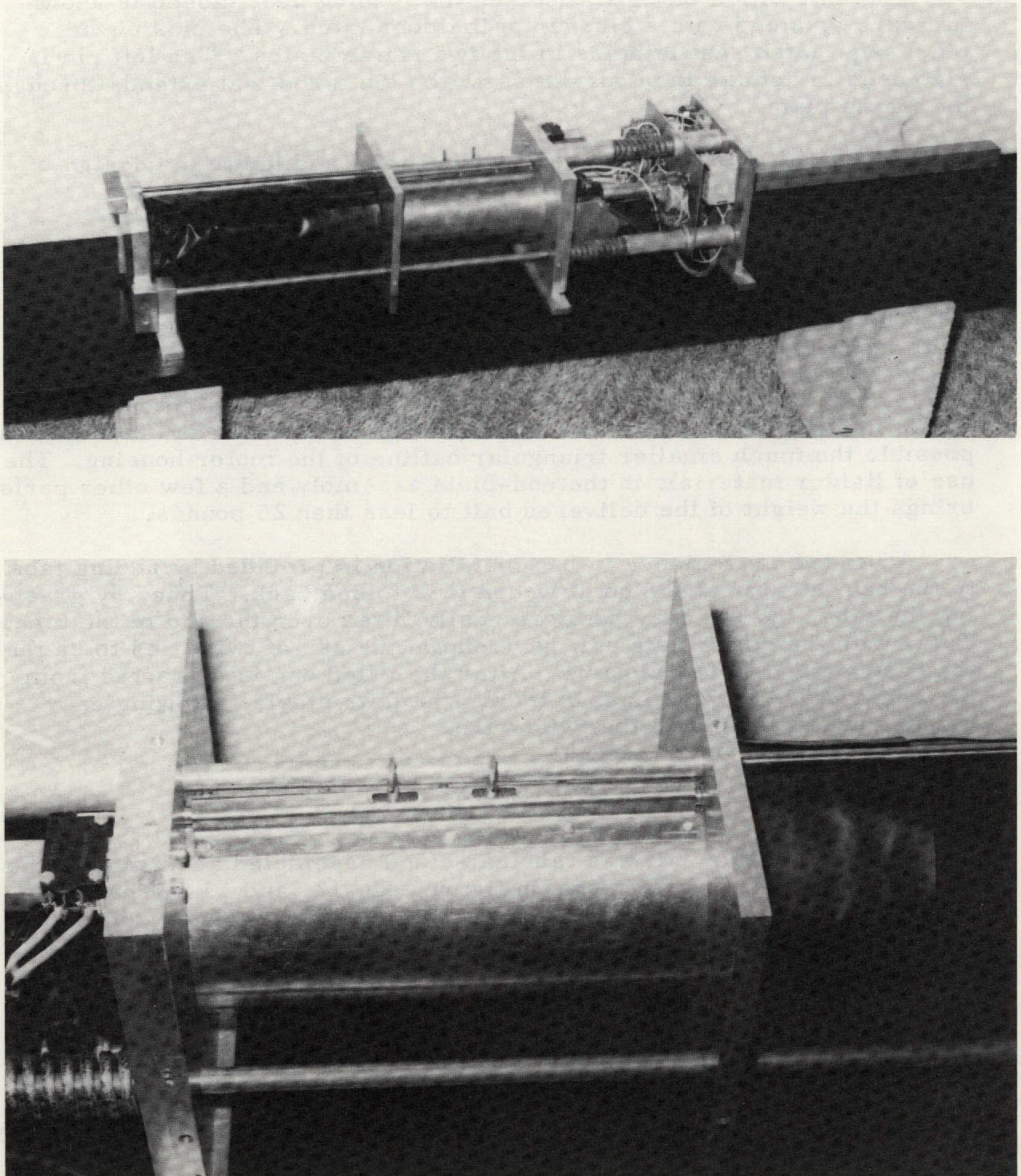


FIGURE 9. – DOOR LATCH AND CLOSED VIEW

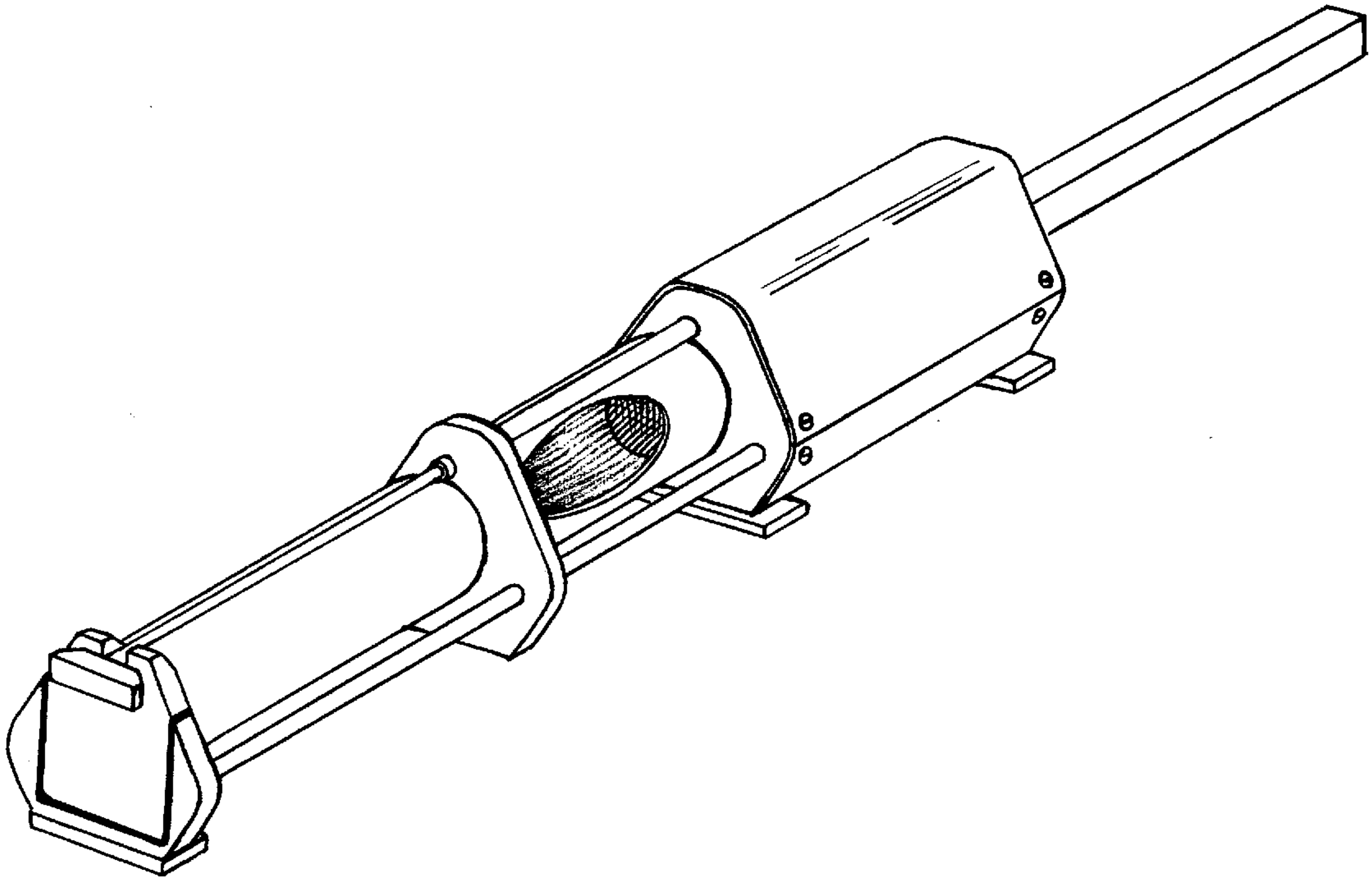


FIGURE 10. — FINAL DESIGN CONFIGURATION

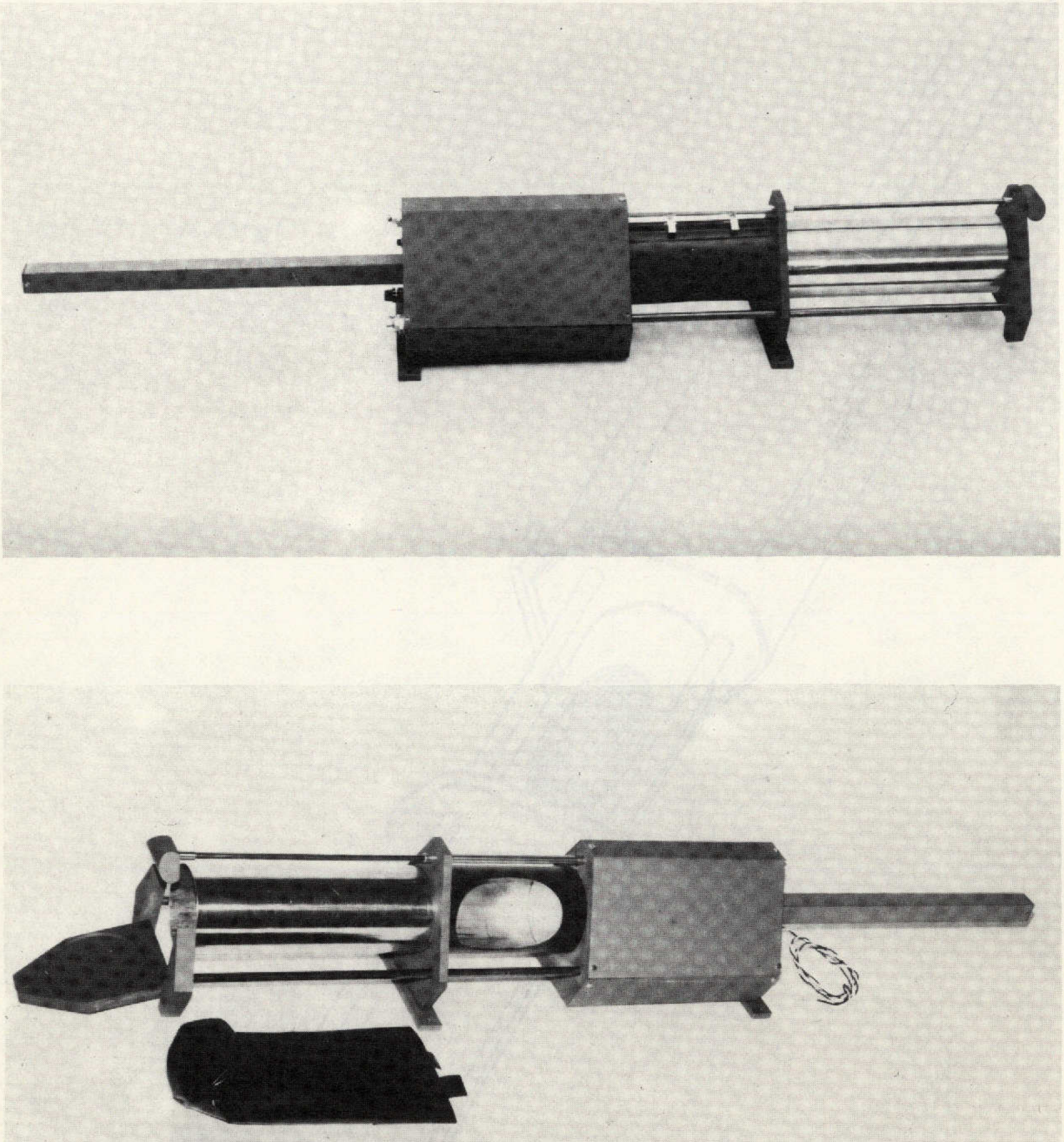


FIGURE 11. — PROTOTYPE TRASH COMPACTING UNIT

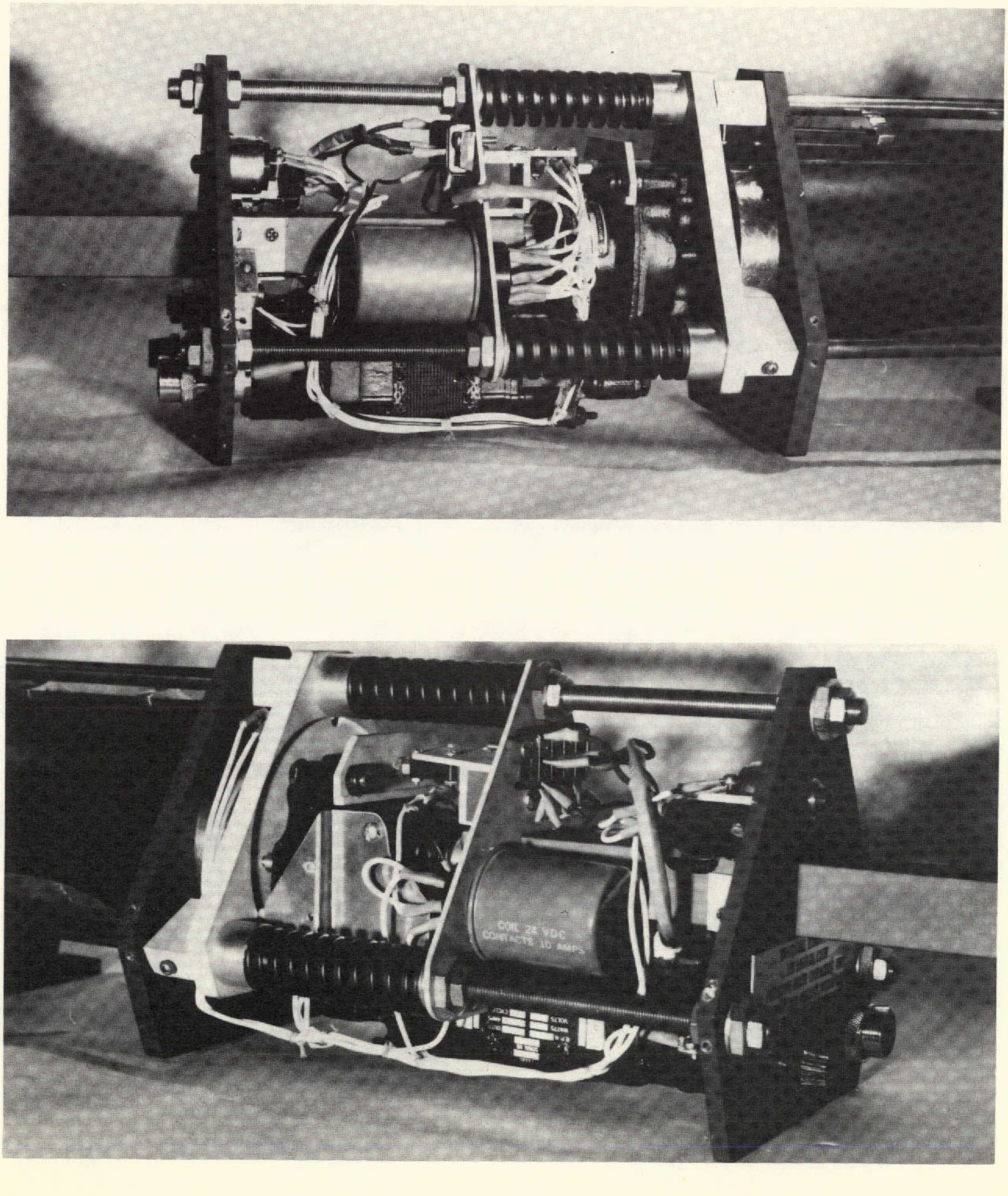
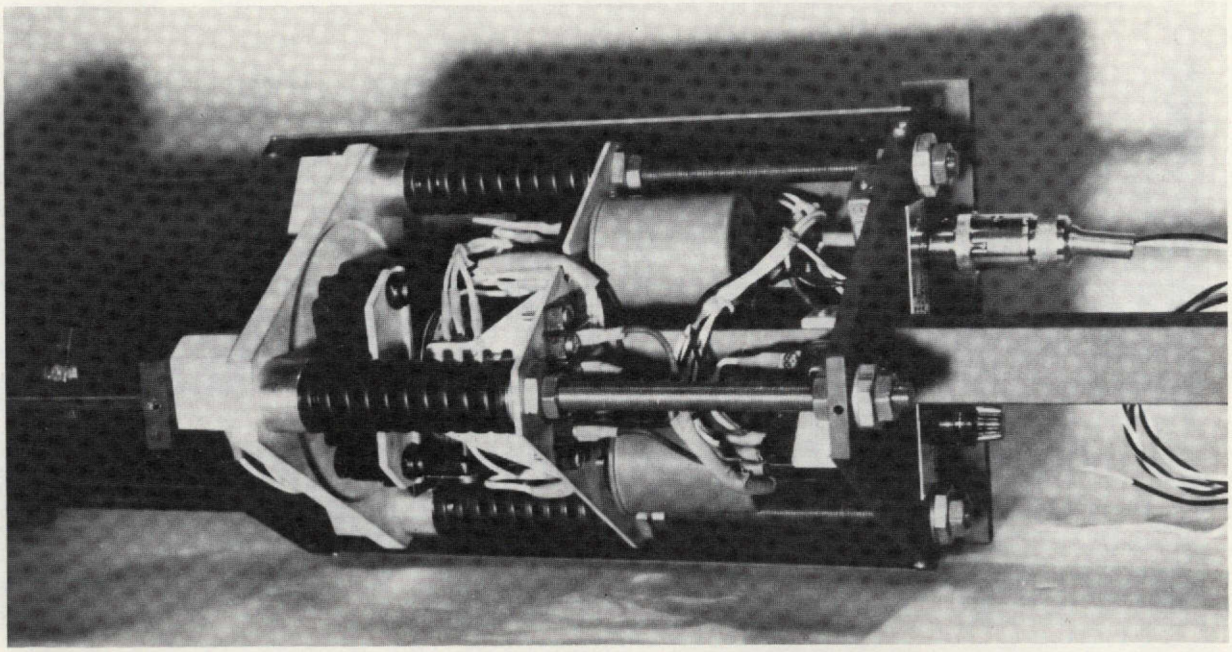


FIGURE 12. — SIDE VIEWS WITH COVER REMOVED



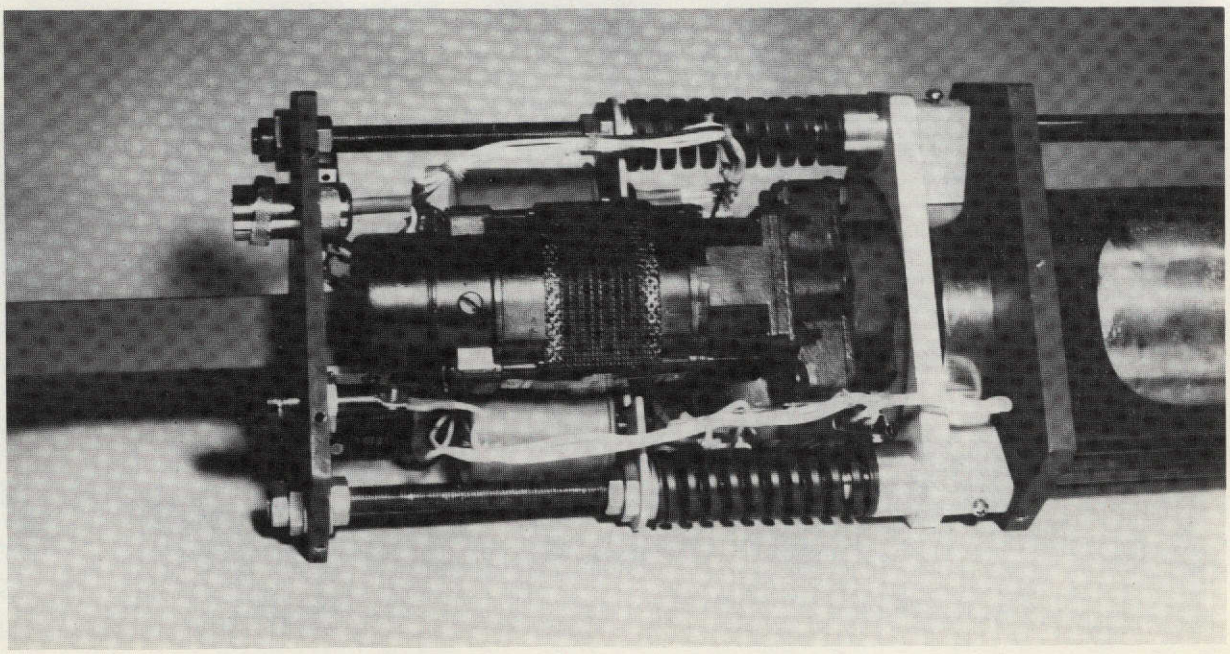


FIGURE 13. — TOP AND BOTTOM VIEWS WITH COVER REMOVED

made the original volume even more difficult to measure, and the opaque barrel of the unit made depth measurements impossible. However, approximately 1/2 cubic foot of loose trash was found to completely fill a trash bag in the compacted state, with a resulting compaction ratio of between 8 and 9 to 1. This is much higher than reported during the force/compaction tests; however, the original volume in those tests was measured after hand-packing the material in the compacting tube, while the original volume used here was that occupied by loose trash in a paper bag. At the end of the testing, which included the complete crushing of an aluminum beverage can, the force was rechecked with the spring scale and found to be 220 pounds.

Difficulty was experienced with only one test. During this test, five 4-by-6-inch aluminum trays were compacted together. When the load was extruded into the bag, the force required became high enough to actuate the load switch, thus prematurely reversing the piston. Several restarts were necessary to completely remove the material from the tube. Therefore, care must be taken in loading too much material of a type which, when compacted, may jam against the sides of the tube and cause difficulty in final removal. Subsequent tests with five trays separated by quantities of paper and cardboard showed no difficulty in removal.

PROPOSED FURTHER DEVELOPMENT

Industrial Ecology, Inc., recognizes that the trash compactor designed and fabricated under the present contract represents the first step in the complete solution of the waste-handling problems of future long-term space missions. Design and bench testing already accomplished has resulted in information that suggests a potential solution to the more complete problem, that of wet and biodegradable wastes.

Extensive study and experience in waste-handling problems have led Industrial Ecology to the conclusion that the most promising solution to the biodegradable waste problem lies in heat sterilization followed by dehydration. Industrial Ecology would like to present a preliminary design concept, based on the prototype trash compactor design, which conveniently solves the total trash problem for space missions. The design concept involves the compaction of mixed trash (dry, wet, biodegradable), followed by steam sterilization, vacuum dehydration, and sealing for long-term efficient storage.

Figure 14 depicts the design concept. The motor-driven piston mechanism is basically identical to the present prototype. The loading and compaction portions of the new concept are the major changes. The unit hinges at the center to facilitate loading. The plastic bag is

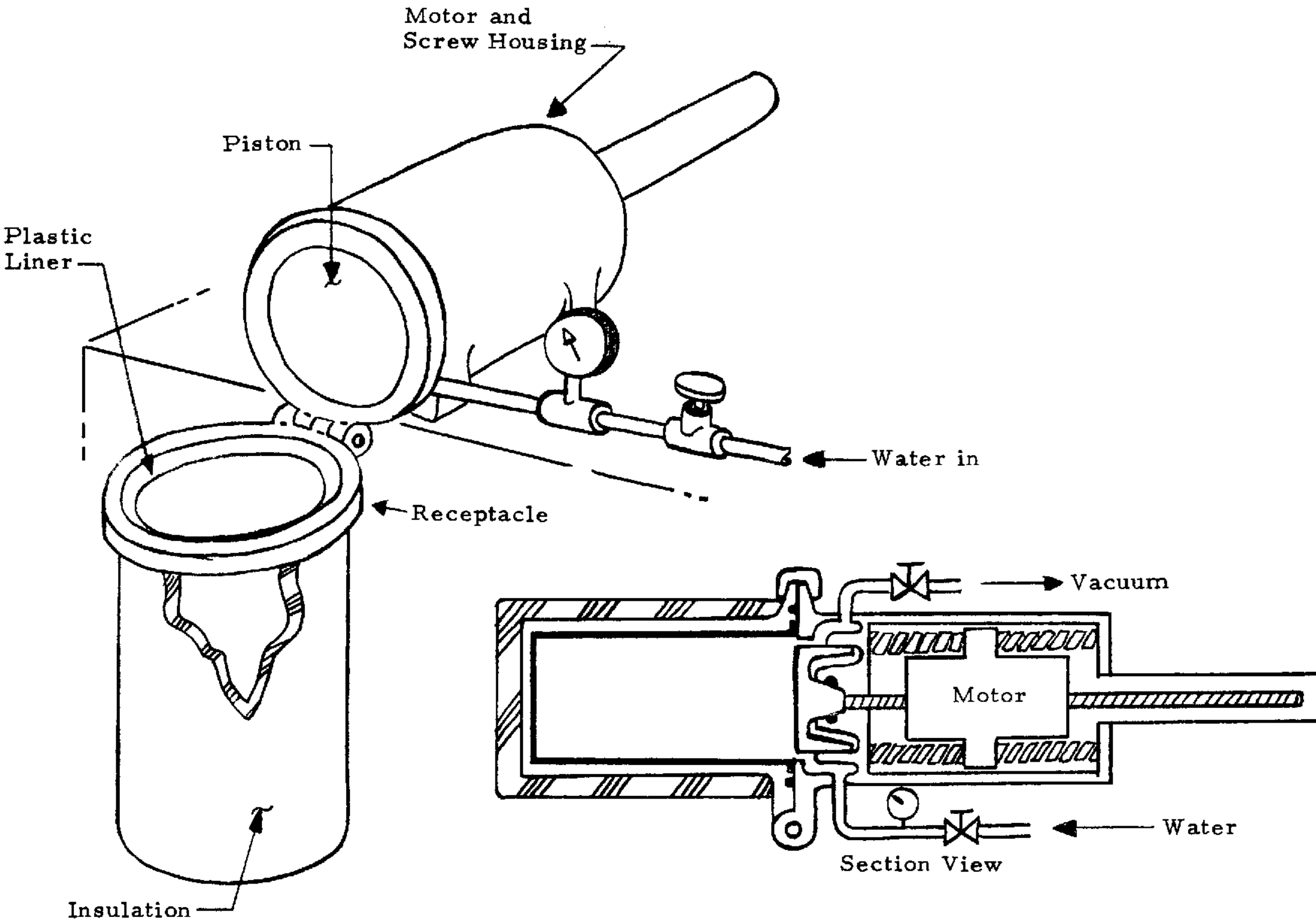


FIGURE 14. — PROPOSED ADVANCED DESIGN CONCEPT

located between a thin-wall stainless-steel tube (in which the piston travels) and the wall of the insulated pressure vessel.

Operation is accomplished by removing the stainless-steel liner, placing a bag over the liner, and placing both within the pressure vessel. Trash (wet or dry) is loaded into the liner until full; the assembly is then raised to the closed position and latched, and the motor is energized to compress the material. The assembly is then opened for further loading. Several liner and bag assemblies could be located throughout the vehicle and used as wastebaskets, being periodically compacted when full of loose material. When the camber is full of compacted material the assembly is latched, and the piston is stopped in the full retracted position that seals the chamber via the O-ring seal at the rear of the piston. A fixed quantity of water is injected into the chamber, and electric heaters imbedded in the walls of the chamber are energized. The unit now acts like an electric autoclave generating its own steam pressure from the added water. After the sterilization cycle is completed, the heaters are shut off and the chamber vented to ambient. At ambient, the piston is moved to recompress the trash, and the chamber is then vented to vacuum. Vacuum dehydration and cooling by evaporation take place, and the unit is cooled to a safe handling temperature. The unit is opened and the bag and liner removed. The liner is then attached to the piston assembly, and the piston is actuated. The trash and bag are extruded from the liner in the same manner as the prototype. The bag is then sealed after addition of a small amount of biocide to prevent surface contamination during the sealing procedure.

Some of the advantages of this design are integrated compaction and sterilization capabilities, repeated sterilization of the compactor, vacuum dehydration, and use of design concepts presently being developed for the prototype. It has been suggested that the concept could also be extended to a wet oxidation process, which points up the great development potential of this new design concept.

APPENDIX

OPERATING INSTRUCTIONS

1. Compactor may be secured to a fixed surface via four number 10 bolts (orientation optional).

2. Connect to 24-volt 10-amp dc power supply.

   Pin number 2 positive
   Pin number 3 negative
   Pin number 1 ground

   Note: Reversed polarity will cause piston to remain at extended position, since time-delay relay that reverses motor is polarity-protected.

3. Open end plate by lifting handle on end of 1/4-inch tie rod.

4. Fold back open end of bag, exposing tabs.

5. Slip bag over end of tube, using tabs.

6. Close end plate.

7. Open loading port by squeezing brass latches together and rotatin black port cover.

8. Insert as much waste material as can easily be packed into interior of loading port.

9. Close port cover by rotating until brass latches snap into their seats.

   Note: The aft latch must be completely extended or the unit will not operate. If this latch is partially opened during operation, the unit will stop.

10. Start compacting operation by <u>momentarily</u> depressing button on aft end plate above square tube. Inadvertent instantaneous touching of the button will not start the unit. The button must be held closed for about 1-2 seconds.

    Note: If the unit is stopped at any time during the cycle by unlatching the loading port, the button must be depressed after relatching the port cover to restart the unit.

    The piston will travel forward until the load reaches the preset level (220 pounds). It then stops and reverses after a 3-second pause to allow the motor to stop. The piston returns to the full open position and stops. The port cover may then be opened and more material loaded.

11. When compacted material reaches the front edge of the loading port, a new bag should be installed.

12. Open end plate by lifting handle.

13. Fold back cuff on bag as far as possible.

14. Momentarily press start button while holding folded part of bag.

15. As bag and compacted material are extruded from the tube, unfold end of bag.

16. Remove bag and material from end of tube and tie bag with twist wire.

17. Install new bag as in step 4.